Claims:

1. A method of detecting obstacles comprising:

producing a depth map of a scene containing terrain; and

processing the depth map to identify regions that do not exceed a mobility constraint for a vehicle, and regions that do exceed the mobility constraint of the vehicle.

2. The method of claim 1 wherein the processing step includes processing data in the depth map to determine a height change of the terrain over a distance represented by pixels in the depth map.

3. The method of claim 1 wherein the processing step further comprises:

computing an amount by which the mobility constraint is exceeded in a region.

4. The method of claim 3 wherein step of computing the amount by which the mobility constraint is exceeded further comprises computing a non-drivable residual.

5. The method of claim 4 wherein the non-drivable residual represents positive or negative elevations beyond limits computed from slope constraints.

6. The method of claim 1 wherein the depth map is a smoothed depth map.

7. The method of claim 6 further comprising:

dividing the depth map into blocks of pixels;

fitting a plane to each of the blocks of pixels; and

identifying a point in the center of each plane as points that form the smoothed depth map.

8. The method of claim 6 further comprising:

identifying a current point (X,Y,Z) representing a current location within the depth map;

subtracting a last point $(X,Y,Z)_L$, which represents a last location within the depth map, from the current point to derive a displacement (ΔX, ΔY, ΔZ);

computing a distance traveled (d_L) between the last point and the current point;

providing a maximum slope (s_{di}) for a drivable incline;

determining uphill and downhill limiting values ($\Delta Y_{uphill} = -s_{di} d_L$ and $\Delta Y_{downhill} = s_{di} d_L$) for a drivable vertical displacement ΔY by multiplying the maximum slope by the distance traveled;

if the vertical displacement ΔY is less than the limiting values, the terrain within the distance traveled is determined to be drivable;

if the vertical displacement ΔY is greater than the limiting values, the terrain within the distance traveled is determined to contain a potential obstacle; and

if a potential obstacle is detected, computing a non-drivable residual to determine whether the potential obstacle is an obstacle.

9. The method of claim 4 wherein the step of computing the non-drivable residual comprises:

identifying a prior location in the depth map that does not contain an obstacle as a last good point $(X,Y,Z)_G$;

computing a second distance traveled (d_G) from the last good point to the current point (X,Y,Z);

computing a residual limiting value ($\Delta Y_{uphill} = -s_{di} d_G$ and $\Delta Y_{downhill} = s_{di} d_G$) for the residual (ΔR_{nd}) by multiplying the maximum slope with the second distance traveled; and

computing the residual as:

$$R_{nd} = \begin{cases} \Delta Y_G - \Delta Y_{downhill}, & \Delta Y_{downhill} < \Delta Y_G \\ 0 & \Delta Y_{uphill} \le \Delta Y_G \le \Delta Y_{downhill} \\ \Delta Y_G - \Delta Y_{uphill} & \Delta Y_G < \Delta Y_{uphill} \end{cases}$$

if the residual is greater than a predefined threshold, then the potential obstacle is an obstacle;

updating the last point with the current point; and

if the residual is zero, then updating the last good point with the current point.

10. Apparatus for detecting obstacles comprising:

a stereo image processor for producing stereo imagery of a scene containing terrain;

a depth map generator for processing the stereo imagery and producing a depth map; and

a depth map processor for processing the depth map to identify regions that do not exceed a mobility constraint for a vehicle, and regions that do exceed the mobility constraint of the vehicle.

11. The apparatus of claim 10 wherein the depth map processor further comprises:

means for computing an amount by which the mobility constraint is exceeded in a region.

12. The apparatus of claim 10 wherein the depth map is a smoothed depth map.

13. The apparatus of claim 12 further comprising:

means for dividing the depth map into blocks of pixels;

means for fitting a plane to each of the blocks of pixels; and

means for identifying a point in the center of each plane as points that form the smoothed depth map.

14. The apparatus of claim 10 wherein the depth map processor comprises:

means for processing each column of data in the depth map to determine the height change of the terrain over the distance represented by pixels in the depth map.

15. The apparatus of claim 14 wherein the depth map processor comprises means for computing a non-drivable residual.

16. The apparatus of claim 15 wherein the non-drivable residual represents the positive or negative elevations beyond limits computed from slope considerations.

17. The apparatus of claim 10 further comprising:

means for identifying a current point (X,Y,Z) representing a current location within the data;

means for subtracting a last point $(X,Y,Z)_L$ representing a last location within the

data from the current point to derive a displacement (ΔX, ΔY, ΔZ);

means for computing a distance traveled (d_L) between the last point and the current point;

means for providing a maximum slope (s_{di}) for a drivable incline;

means for determining uphill and downhill limiting values ($\Delta Y_{uphill} = -s_{di} d_L$ and $\Delta Y_{downhill} = s_{di} d_L$) for a drivable vertical displacement ΔY by multiplying the maximum slope by the distance traveled;

if the vertical displacement ΔY is less than the limiting values, the terrain within the distance traveled is determined to be drivable;

if the vertical displacement ΔY is greater than the limiting values, the terrain within the distance traveled is determined to contain a potential obstacle; and

if a potential obstacle is detected, the depth map processor computes a non-drivable residual to determine whether the potential obstacle is an obstacle.

18. The apparatus of claim 15 wherein the depth map processor further comprises:

means for identifying a good point $(X,Y,Z)_G$ as a prior location that does not contain an obstacle;

means for computing a second distance traveled (d_G) from the last good point to the current point (X,Y,Z);

means for computing a residual limiting value ($\Delta Y_{uphill} = -s_{di} d_G$ and $\Delta Y_{downhill} = s_{di} d_G$) for the residual (R_{nd}) by multiplying the maximum slope with the second distance traveled; and

means for computing the residual as:

$$R_{nd} = \begin{cases} \Delta Y_G - \Delta Y_{downhill}, & \Delta Y_{downhill} < \Delta Y_G \\ 0 & \Delta Y_{uphill} \le \Delta Y_G \le \Delta Y_{downhill} \\ \Delta Y_G - \Delta Y_{uphill} & \Delta Y_G < \Delta Y_{uphill} \end{cases}$$

if the residual is greater than a predefined threshold, then the potential obstacle is an obstacle.

19. An obstacle detecting system comprising:

a vehicle having a movement system for moving the vehicle across a terrain;

a stereo image processor mounted to the vehicle, the stereo image processor for producing stereo imagery of a scene containing the terrain;

a depth map generator for processing the stereo imagery and producing a depth map; and

a depth map processor for processing the depth map to identify regions that do not exceed a mobility constraint for the vehicle, and regions that do exceed the mobility constraint of the vehicle.

20. The obstacle detecting system of claim 19 further including:

an obstacle detector responsive to the depth map processor, the obstacle detector for identifying an obstacle in the path of the vehicle that exceeds the mobility constraint of the vehicle; and

a control system that controls the movement system so as to move the vehicle around the identified obstacle.

21. The obstacle detecting system of claim 19 further including:

an obstacle detector responsive to the depth map processor, the obstacle detector for identifying an obstacle in the path of the vehicle that exceeds the mobility constraint of the vehicle; and

a warning system that signals when an obstacle in the path of the vehicle is identified.

22. The obstacle detecting system of claim 19 wherein the depth map processor includes means for computing an amount by which the mobility constraint is exceeded in a region, and wherein the depth map is a smoothed depth map.

23. The obstacle detecting system of claim 22 further comprising:

means for dividing the depth map into blocks of pixels;

means for fitting a plane to each of the blocks of pixels; and

means for identifying a point in the center of each plane as points that form the smoothed depth map.

24. The obstacle detecting system of claim 19 wherein the depth map processor includes means for processing each column of data in the depth map to determine the height change of the terrain over the distance represented by pixels in the depth map, and means for computing a non-drivable residual that represents the positive or

negative elevations beyond limits computed from slope considerations.

25. The obstacle detecting system of claim 19 further comprising:

means for identifying a current point (X,Y,Z) representing a current location within the data;

means for subtracting a last point $(X,Y,Z)_L$ representing a last location within the data from the current point to derive a displacement (ΔX, ΔY, ΔZ);

means for computing a distance traveled (d_L) between the last point and the current point;

means for providing a maximum slope (s_{di}) for a drivable incline;

means for determining uphill and downhill limiting values ($\Delta Y_{uphill} = -s_{di} d_L$ and $\Delta Y_{downhill} = s_{di} d_L$) for a drivable vertical displacement ΔY by multiplying the maximum slope by the distance traveled;

if the vertical displacement ΔY is less than the limiting values, the terrain within the distance traveled is determined to be drivable;

if the vertical displacement ΔY is greater than the limiting values, the terrain within the distance traveled is determined to contain a potential obstacle; and

if a potential obstacle is detected, the depth map processor computes a non-drivable residual to determine whether the potential obstacle is an obstacle.

26. The obstacle detecting system of claim 19 wherein the depth map processor further comprises:

means for identifying a good point $(X,Y,Z)_G$ as a prior location that does not contain an obstacle;

means for computing a second distance traveled (d_G) from the last good point to the current point (X,Y,Z);

means for computing a residual limiting value ($\Delta Y_{uphill} = -s_{di} d_G$ and $\Delta Y_{downhill} = s_{di} d_G$) for the residual ($R_{nd}$) by multiplying the maximum slope with the second distance traveled; and

means for computing the residual as:

$$R_{nd} = \begin{cases} \Delta Y_G - \Delta Y_{downhill}, & \Delta Y_{downhill} < \Delta Y_G \\ 0 & \Delta Y_{uphill} \leq \Delta Y_G \leq \Delta Y_{downhill} \\ \Delta Y_G - \Delta Y_{uphill} & \Delta Y_G < \Delta Y_{uphill} \end{cases}$$ if the residual is greater than a predefined threshold, then the potential obstacle is an obstacle.